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The Global Public Health Issue of Pharmaceutical Waste: What Role for Pharmacists?

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Abstract

Pharmaceuticals have played an important role in improving the quality of life of the human population in modern times. However, it must also be acknowledged that both the production and use of pharmaceuticals have a significant, negative impact on the environment and consequently, a negative impact on the health of humans and wildlife. This negative impact is due to the embedded carbon in pharmaceuticals' manufacture and distribution and the waste generated in their manufacture, consumption and disposal. Pharmaceutical waste is comprised of contaminated waste (unwanted pharmaceuticals and their original containers) and non-contaminated waste (non-hazardous packaging waste). Pharmacists, with their professional commitment to the quality use of medicines and their active participation in the medicines management pathway, already play an important role in the more sustainable use of pharmaceuticals. Even so, they have the potential to play an even greater role with the environmentally responsible disposal of pharmaceutical waste (including packaging waste) and the education of other health professionals and the general public on this topic.

Keywords

Pharmaceuticals, pharmaceutical waste, pharmacists, hospital pharmacists, sustainable, environmentally responsible, pharmaceutical waste disposal

Introduction

Pharmaceuticals have played an important role in improving the quality of life of the human population in modern times (e.g. pharmaceuticals such as penicillin, insulin, smallpox and polio vaccines, aspirin, morphine, oral contraceptives and digoxin). Whilst acknowledging the importance of the role of pharmaceuticals in improving many 'quality of life' markers in the domains of human physical, mental and social wellbeing, it must also be acknowledged that pharmaceuticals and their packaging have a significant negative impact on the environment. This negative impact is due to the embedded carbon in pharmaceuticals' manufacture and distribution and through the waste generated in their manufacture, consumption and disposal (Gell, 2010). There are both negative impacts on the health of humans (Blashki et al., 2011; Costello et al., 2009; Intergovernmental Panel on Climate Change, 2007) and on the health of wildlife (Arnold et al., 2013; Jobling, Nolan, Tyler, Brighty, & Sumpter, 1998; Jones, Voulvoulis, & Lester, 2003). Despite the evidence in the literature highlighting the negative impacts of pharmaceuticals on the health of humans and wildlife, there is very little research reported in international and national pharmacy or medical literature on pharmacists' attitudes and behaviours regarding the environmentally responsible handling of pharmaceutical waste. In this paper, the authors argue that pharmacists could and should play a major role in minimising the negative impact of pharmaceutical waste on the environment.

The Negative Impact of Pharmaceuticals on the Environment

The negative impact of pharmaceuticals on the environment originates from three sources (Kummerer & Hempel, 2010). These are the carbon footprint of pharmaceuticals through the embedded carbon in their manufacture and distribution and the incineration of unwanted pharmaceuticals and original containers, the chemical effects of the pharmaceuticals themselves and their packaging waste. Each of these will now be examined in turn. The first source of environmental impact of pharmaceuticals is through the carbon footprint. The size of the carbon footprint of pharmaceuticals in the public hospital sector is significant. For example, in the NHS England pharmaceuticals comprised 22% of the total carbon footprint in 2010, equating to 4.4 million tonnes of CO₂ emissions, which in turn comprises 3% of the UK's total carbon footprint (NHS Sustainable Development Unit, 2012). The second source of environmental impact due to pharmaceuticals, as described by Kummerer and Hempel (2010), is the direct chemical impact on the environment of the pharmaceuticals themselves. The issue of pharmaceuticals in the environment has been of growing concern both amongst the public and the scientific community for over two decades (Bound, Kitsou, & Voulvoulis, 2006; Calisto & Esteves, 2009; da Graca Martinho & Martins dos Santos, 2011; Eissen & Backhaus, 2011; Jobling et al., 1998; Kümmerer, 2010; Mompelat, Le Bot, & Thomas, 2009; Ternes, 1998; Vallini & Townend, 2010). Over the last decade there has been an increasing body of published research on this topic (Arnold et al., 2013). Even though pharmaceuticals appear in very low concentrations in the environment and thus would appear to pose a negligible risk to humans (Cunningham, Binks, & Olson, 2009; Fent, Weston, & Caminada, 2006; Sherer, 2006) they have the potential to exert a cumulative effect on humans (Ruhoy & Daughton, 2008), a negative effect on human fetuses (Koshy, 2013) and a significant negative impact on wildlife. For example, exposure

to the pharmaceutical diclofenac has resulted in the virtual extinction of vultures in Asia (Arnold et al., 2013; Oaks et al., 2004; Ogada, Keesing, & Virani, 2012; Sumpter, 2010; Swan et al., 2006). Diclofenac is a non-steroidal anti-inflammatory drug (NSAID) and is readily available over the counter of pharmacies without a doctor's prescription. Veterinary use of this widely-available NSAID has resulted in the virtual extinction of three vulture species to the most severe category of global extinction risk (Swan et al., 2006). Vultures in Asia have been exposed to diclofenac when scavenging on dead livestock that were treated with diclofenac shortly before death (Oaks et al., 2004; Swan et al., 2006). Exposure leads to renal damage, gout, acute renal failure and death (Swan et al., 2006).

Pharmaceuticals enter the environment via a number of pathways but mostly from patient excretion or the disposal of unwanted pharmaceuticals. The size of the issue is brought into context when one considers that the global pharmaceuticals market is worth US\$300 billion a year, a figure expected to rise to US\$400 billion within three years (World Health Organisation, 2013). Of these pharmaceuticals, up to 90% of each administered dose may be excreted unchanged with the potential for metabolites to be converted back to active compound by the action of bacteria during the sewerage treatment process (Jones, Voulvoulis, & Lester, 2001). This transformation during the sewerage treatment process may alter the physical and chemical properties of the pharmaceutical and determine whether it will partition into the sludge or liquid phase of the sewerage treatment process (Jones et al., 2001; Ternes, 1998). Unfortunately, sewerage treatment plants fail to remove a significant portion of these active compounds from either the liquid or the sludge phases (Fisher & Borland, 2003; Jones et al., 2001; Joss et al., 2006) resulting in large amounts of pharmaceuticals entering the environment. Pharmaceuticals leaving sewerage treatment plants can end up in water for agricultural and landscape re-use and potentially in recycled drinking water for human and animal consumption. Pharmaceuticals may also be retained as active compounds in the sludge phase with entry points into soil, groundwater and drinking water. The disposal of pharmaceutical waste, either by incineration or into landfill, or disposal down sinks or toilets that ends up in the sewerage system, creates entry points into the atmosphere or into ground water that may potentially enter drinking water. Through entry into drinking water there is the potential for pharmaceuticals to affect both the health of aquatic organisms as Jobling et al's (1998) research demonstrated and the health of humans.

The third source of environmental impact due to pharmaceuticals, as described by Kummerer and Hempel (2010), is due to pharmaceuticals' packaging waste. Pharmaceutical packaging waste is comprised of several components – the original container (the bottle, box or vial that contains or contained the pharmaceutical), cardboard outers, paper from consumer information leaflets and/or product information for health professionals, shrink wrap, foil strips for individual oral dose formulations, cartons and wooden pallets. Pharmaceutical waste may be separated into contaminated waste (unused pharmaceuticals and their original containers) and non-contaminated waste (packaging materials). WHO classifies unwanted pharmaceuticals and their original containers as contaminated waste requiring high temperature incineration to minimize the risk of pharmaceuticals entering

the natural environment (World Health Organisation, 2011). Non-contaminated pharmaceutical packaging waste is classified as non-hazardous, general waste that may be recyclable or compostable (World Health Organisation, 2011). Pharmaceutical packaging differs substantially from food packaging. It requires scientific and engineering expertise to ensure pharmaceuticals do not leach out of their original containers in transit and arrive at their destination with efficacy unchanged. The packaging must ensure that the pharmaceutical's stability, sterility and purity remains uncompromised (Bauer, 2009). Pharmaceutical packaging must also be made of materials that will not themselves chemically react with the pharmaceutical, will provide thermal protection, and will prevent moisture and oxygen coming into contact with the pharmaceutical and reacting with it (Bauer, 2009). With increasing pressure being applied by stakeholders to the pharmaceutical sector to become more environmentally responsible (Leaver, 2008), pharmaceutical packaging materials are beginning to change (Bauer, 2009). Traditional pharmaceutical packaging materials such as glass, metal and older plastics such as polyvinyl chloride (PVC) are being replaced with newer and more efficient materials such as crystalline and biologically derived plastics (Bauer, 2009). Innovation in this area is vital as the older plastics used in pharmaceutical packaging have a high volume-to-weight ratio and contribute significantly to landfill (Bauer, 2009). Wooden pallets are also a problem in some cases with companies not being allowed to recycle them due to concerns about the wooden fibres affecting the quality of the product (Leaver, 2008). With space for landfill now becoming a concern in many countries (Bauer, 2009; Singh, Sharma, & Malviya, 2011), reducing landfill through the recycling of pharmaceutical packaging waste potentially has important implications for the environment and for hospitals in reducing their waste removal costs. In Australia, manufacturers and suppliers are encouraged to reduce the amount of packaging waste or move to more ecofriendly packaging materials to reduce the environmental impact of packaging materials across all industries. In 1999, the National Packaging Covenant (name changed to Australian Packaging Covenant (APC) in 2010) was launched with the aim of changing the culture of business to design more sustainable packaging, increase recycling rates and reduce packaging litter. The APC is an agreement between government, industry and community groups to address packaging sustainability issues (Australian Packaging Covenant, 2013a). The APC aims to reduce the environmental impact of consumer packaging by encouraging the design of packaging that is more resource efficient and more recyclable and increasing the recovery and recycling of used packaging (Allan & A'Vard, 2013). To encourage companies to sign up to the APC, Australian State governments require that companies with an annual turnover greater than \$5 million either sign the APC or comply with the 'National Environmental Protection Measure (Used Packaging Materials) 2011' (Australian Packaging Covenant, 2013a). Many pharmaceutical manufacturers and suppliers with offices in Australia are signatories to the APC but some of the largest suppliers of generic pharmaceuticals into Australia are based in India and they are not signatories (Australian Packaging Covenant, 2013b). Minimising the impact of pharmaceuticals on the environment lies with maximising resource efficiency to reduce the actual amount of waste produced and ensuring the most environmentally responsible disposal of this pharmaceutical waste. These two options will now be discussed.

Maximising Resource Efficiency

Globally, it is estimated that less than half of all patients are treated in compliance with medical guidelines and more than half of all patients fail to take their medicines as prescribed or dispensed (Holloway, 2011). Non-adherence is a global issue with non-adherent rates of approximately 50% amongst patients with chronic disease in developed countries and even higher in developing countries (World Health Organisation, 2003). Such inappropriate use is not only an inefficient use of resources and hence wasteful, but it also “causes patient harm in terms of lack of satisfactory outcome, serious adverse events and increased antimicrobial resistance” (Holloway, 2011) p. 335. The efficient use of pharmaceuticals is referred to by the World Health Organisation (WHO) (1985) as the rational use of medicines which occurs “when patients receive the appropriate medicines, in doses that meet their own individual requirements, for an adequate period of time and at the lowest cost, both to them and the community” (Holloway, 2011) p. 335. The challenge of resource efficiency was first responded to in Australia through the Pharmaceutical Benefits Scheme (PBS), introduced in 1950 to ensure equity of access to safe and affordable medicines for all Australians (Hunt, 2010). Then it was further addressed through the National Medicines Policy (NMP) introduced in 2000 with one of its central objectives being the Quality Use of Medicines. The Quality Use of Medicines argues for the judicious, appropriate, safe and efficacious use of medicines (Australian Government, 2000). Ultimately, it was the economic cost to the Australian Government of the burgeoning PBS that was the key driver for the development of a National Medicines Policy (Hunt, 2010) and it continues to be the main driver of resource efficiency (Treasury, 2010) p.49. Environmental considerations are not a driver but rather, a co-benefit, of cost-driven resource efficiency and patient safety measures in Australia.

Disposal of Pharmaceutical Waste

The disposal of pharmaceutical waste refers to the disposal of unwanted pharmaceuticals and pharmaceuticals’ packaging. Unwanted pharmaceuticals include expired, unused and contaminated pharmaceuticals (Koshy, 2013; Taylor, 2010) all of which cannot be reused and require disposal. Factors contributing to the accumulation of unwanted pharmaceuticals include changes in dose, death of patient, non-adherence to therapy or non-completion of course of therapy (e.g. antibiotics or analgesics) and discontinuation of treatment due to unpleasant side effects (Daughton & Ruhoy, 2008; Koshy, 2013; Taylor, 2010; Vollmer, 2010). Over-prescribing of pharmaceuticals by doctors is also a contributor to excess unwanted pharmaceuticals (Ekedahl, 2006). The role of pharmacists through the Quality Use of Medicines, as described earlier, and as set down in the ‘Consensus Statements’ (International Pharmaceutical Federation (FIP), 2008) aims to reduce the amount of unwanted pharmaceuticals in the community. Globally, there is much confusion as to the most appropriate means of disposing of unwanted pharmaceuticals (Tong, Peake, & Braund, 2011). A review of the literature on the disposal of unwanted pharmaceuticals by the public found that the most popular methods were in the household garbage or tipped down the toilet or sink (Tong et al., 2011). Liquid formulations were more likely to be disposed of down the sink or toilet whilst solid formulations were more likely to be disposed of in the garbage (Braund, Peake, & Shieffebien, 2009; Gotz & Deffner, 2010;

Kotchen, Kallaos, Wheeler, Wong, & Zahller, 2009; Tong et al., 2011). All of these methods have a negative impact on the natural environment (Braund et al., 2009; Daughton & Ruhoy, 2009; Vollmer, 2010). Even though WHO has provided best practice guidelines recommending high temperature incineration for contaminated pharmaceutical waste (World Health Organisation, 2011) there is still confusion as to how to dispose of pharmaceuticals. Another issue is access by the public to high temperature incineration facilities. High temperature incineration is available to hospitals in many countries through contracts with private waste management firms. However, community access to such means of disposal for household pharmaceutical waste is problematic leading to disposal that allows pharmaceuticals to enter the environment. In Australia, the public are encouraged to return unwanted medicines to their local community pharmacy for disposal as part of the Return of Unwanted Medicines (RUM) project (2011). These returned medicines are collected free of charge from each participating community pharmacy and taken to a central location for incineration. Currently in either community or hospital pharmacy settings in Australia, non-contaminated packaging waste is not separated out from the contaminated waste with returned unwanted pharmaceuticals – both contaminated and non-contaminated waste are incinerated adding to greenhouse gas emissions. During the dispensing of new prescriptions, any unrequired packaging waste tends to go into general waste bins destined for landfill.

The Role of Pharmacists

Pharmacists have a potential role to play in minimising the impact of pharmaceuticals on the environment both through maximising resource efficiency to reduce the actual amount of waste produced and ensuring the most environmentally responsible disposal of this pharmaceutical waste. Much research has already been conducted worldwide in the area of pharmacists' contributions to the efficient use of medicines (the quality use of medicines) including research in the area of patient adherence (Vermeire, Hearnshaw, Van Royen, & Denekens, 2001) and preventative health strategies to reduce the amount of pharmaceuticals dispensed (Daughton & Ruhoy, 2010). The development of the medicines management pathway which describes the cognitive and physical steps and processes in the use of medicines (Stowasser, Allinson, & O'Leary, 2004) highlighted the areas where pharmacists could influence the quality use of medicines i.e. the judicious, appropriate, safe and efficacious use of medicines. The importance of the role of pharmacists in the efficient use of medicines is acknowledged in published literature (Graudins, 2004; Smith, 2012; Tan, Stewart, Elliott, & George, 2012). This body of literature includes the important role played by hospital pharmacists (Abdel-Qader, Harper, Cantrill, & Tully, 2010; Claus, Barbara, Fien, & Hugo, 2012; Gardner & Graner, 2009; Haavik et al., 2011; Raman-Wilms, 2010; Torelli, Reis, Scopel, Correr, & Andrzejewski, 2013). With regards to the role that pharmacists can play in ensuring the most environmentally responsible disposal of pharmaceutical waste, more research is needed in this area. There has been much research in the last twenty years on the presence of pharmaceuticals in the environment, the impact of pharmaceutical waste and the disposal of medicines in the community. However, there has been very little research into the attitudes and behaviours of pharmacists regarding the disposal of pharmaceutical waste. There have been calls for research into the disposal of unused pharmaceuticals (Daughton & Ruhoy, 2008; Koshy, 2013; Tong et al., 2011) and for research

into the attitudes of pharmacists regarding the disposal of unwanted pharmaceuticals and their knowledge regarding the most appropriate methods for doing so (Koshy, 2013).

Pharmacists can play a very important role in encouraging the environmentally responsible handling of pharmaceutical waste. In Australia this role may be of greater importance in the hospital pharmacy context compared with the community pharmacy context for two reasons. First, pharmacists exert a wider sphere of influence over medication usage and disposal in the hospital pharmacy context compared with the community pharmacy context (International Pharmaceutical Federation (FIP), 2008). In the hospital pharmacy context, pharmacists not only dispense medicines directly to patients but they also play a wholesaler function in supplying other departments in the hospital with pharmaceuticals. The hospital pharmacy department supplies outlying clinics such as oncology and renal medicine, the operating theatres and medical imaging with pharmaceuticals used in their clinical practices as well as directly supplying pharmaceuticals to patients on prescriptions. This dual role (wholesaler and dispensing) means that hospital pharmacists exert a wide sphere of influence over the use of pharmaceuticals in the hospital setting. This sphere of influence is articulated in the 'Consensus Statements' agreed upon at the International Federation of Pharmacists' (FIP) 2008 conference (International Pharmaceutical Federation (FIP), 2008). The overarching statements call for hospital pharmacists to be involved in all steps in the supply of medicines¹ within a hospital and that the Chief Pharmacist/Director of Pharmacy should be the senior professional responsible for coordinating the judicious, safe, efficacious, appropriate and cost-effective use of medicines in the hospital. Hospital pharmacists should be responsible for all medicines' logistics within the hospital setting and should serve as a resource for all information concerning medicines, providing education to other health professionals regarding best practices for medicines use. Spheres of influence articulated in these statements as themes include procurement, prescribing (hospital pharmacists should have a key role in educating prescribers on the access to and evidence for optimal and appropriate use of medicines), and the packaging, labelling and storage of medicines throughout the hospital (International Pharmaceutical Federation (FIP), 2008). Thus it can be seen that the sphere of influence of hospital pharmacists extends beyond the confines of the hospital pharmacy department. The second reason why hospital pharmacists working in Australia may play a greater role compared with community pharmacists is because a greater volume of pharmaceuticals is handled in hospitals compared with the community (Australian Institute of Health and Welfare, 2012). By identifying the enablers and barriers to the environmentally responsible handling of pharmaceutical waste by hospital pharmacists and pharmacy technicians there is the potential for flow-on effects around the hospital. These are twofold. There is the potential for a reduction in the actual amount of pharmaceutical waste produced and for more environmentally responsible handling of the pharmaceutical waste that is produced. The potential role that hospital pharmacists can play in reducing the environmental impact of pharmaceuticals has been identified as an area requiring research (Koshy, 2013). A recent study conducted in Kuwait (Abahussain, Waheedi, & Koshy, 2012) examined the practices, awareness and opinions of hospital pharmacists working in government hospitals regarding

¹The term 'medicines' in these statements may be used interchangeably with the term 'pharmaceuticals' used elsewhere in this document.

the disposal of unwanted pharmaceuticals. The findings would appear to support this call for further research. It was found that although the pharmacists were aware of the harmful impact of the improper disposal of unwanted pharmaceuticals, their disposal practices were suboptimal (Abahassain, Waheedi, & Koshy, 2012). Other researchers have also drawn attention to the contribution of hospitals to the environmental impact of pharmaceuticals (Escher et al., 2011; Le Corre et al., 2012; Lin & Tsai, 2009; Thomas & Langford, 2010). There have been calls for greater awareness of this issue on the part of health professionals and for health sector reform to minimize this environmental impact (Fisher, Smith, & Collignon, 2013).

Conclusion and Implications

Pharmacists, with their professional commitment to the quality use of medicines and their active participation in the medicines management pathway, already play an important role in the more sustainable use of pharmaceuticals. Even so, they have the potential to play an even greater role with the environmentally responsible disposal of pharmaceutical waste and the education of other health professionals and the general public on this topic. At a national level, the implementation and active promotion of community pharmacy initiatives such as Australia's Return of Unwanted Medicines (RUM) project, which encourage the public to return unwanted medicines to pharmacies for correct disposal will minimise the negative impact of pharmaceuticals on the environment. Also, health care organisations need to show leadership by encouraging pharmacists and other medical staff both in the hospital and community pharmacy settings to separate out non-contaminated packaging waste from contaminated waste. There will be less waste incinerated thereby reducing the carbon footprint and hospital waste management costs and if pharmacists are able to recycle or shred the packaging waste for composting, less waste ending up in landfill.

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